list increase the number of lichen-forms, now known from the state, to 318 and the number of species to 240.

In the Catalogue records from 79 Connecticut towns were given, leaving 90 towns from which no reports on lichens had been received. The explorations of 1926 give records from 9 additional towns, reducing the number still to be heard from to 81. In the Catalogue the towns from which 10 species or more had been reported numbered 36; to these towns the following, 7 in number, may now be added: Greenwich, Kent, New Canaan, Old Saybrook, Salisbury, Southbury, and Stamford. The 5 towns standing at the head of the list, with the number of species recorded from each, are as follows: Killingworth, 95; Guilford, 53; New Haven, 52; Bethany, 51; and Washington, 46.

In the Catalogue only 5 species were reported from 20 or more towns apiece, while 22 were reported from 10 to 20 towns apiece. These numbers may now be raised to 10 and 27, respectively. The 10 leading species of the state, according to the present records, with the number of towns from which each species has been reported, are the following: *Parmelia caperata*, 36; *P. rudecta* and *Physcia stellaris*, 30 each; *Cladonia cristatella* and *Parmelia conspersa*, 28 each; *Physcia obscura*, 26; *Ph. tribacia*, 24; *Cladonia furcata*, *C. sylvatica*, and *Lecidea albocaerulescens*, 21 each. In the Catalogue the leading species, *Parmelia caperata*, had only 29 towns to its credit. The species, additional to those noted in the Catalogue, which are now known from 10 or more towns apiece, are the following: *Alectoria chalybeiformis*, *Candelariella vitellina*, *Cladonia rangiferina*, *C. uncialis*, *Dermatocarpon aquaticum*, *Gyrophora Muhlenbergii*, *Pertusaria pustulata*, *Physcia aquila*, *Ph. pulverulenta*, and *Rinodina oreina*.

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EFFECTS OF POST-PLEISTOCENE SUBMERGENCE IN EASTERN NORTH AMERICA.

H. K. Svenson.

(*Continued from p. 93.*)

Halophytes occurring on the Atlantic Coast and in the Saline Regions of Western North America.

Before discussing the Champlain Sea as a means of dispersal of halophytes, it may be well to consider the distribution of halophytes

which occur on the Atlantic coast and also in the regions west of the Great Lakes. St. John and Courtney[1] have recently described the striking similarity or identity of plants about a saline lake in Okanogan County, Washington, with those inhabiting the salt marshes of the sea coast. Upham,[2] in 1890, listed the plants about the saline springs in the Canadian Northwest, and from him the following quotation and list is made. "The following plants peculiar to the seashore and its salt marshes, not found elsewhere in the Eastern States and Provinces, excepting some of them at salt springs in New York and along the shores of the Great Lakes, reappear in abundance on the saline and alkaline soil in certain parts of the Red River Valley, and of the western prairies and arid plains:

Buda marina Dumort [*Spergularia* sp.]
Glaux maritima L.
Heliotropum Curassavicum L.
Plantago eriopoda Torr.
Chenopodium rubrum L.
Atriplex patulum L. var. *hastatum* Gray.
Salicornia herbacea L.
Salsola Kali L.
Rumex salicifolius Weinmann [*R. mexicanus* Meisn.]
Rumex maritimus L. [var. *fuegi-nus* (Dusén) Phil.]
Triglochin maritima L.
Scirpus maritimus L. [*S. campestris*, var. *paludosus* (A. Nels.) Fern.]
Distichlis maritima Raf. in its var. *airoides* Vasey
[Probably *Puccinellia airoides* Wats. & Coult. or *P. Cusickii* Weatherby. See RHODORA **18**: 181–183. 1916.]
Hordeum jubatum L.

[To the above enumeration may be added *Scirpus rufus* (Huds.) Schrad., and *Plantago oliganthos* R. & S., both of which are represented by specimens in the Gray Herbarium.]

Coville[3] reports a somewhat similar group of halophytes and indifferent halophytes from Death Valley, including such plants as *Typha angustifolia, Triglochin maritima, Zannichellia palustris, Ruppia maritima, Eleocharis rostellata, Scirpus acutus, Scirpus campestris* and *Ranunculus Cymbalaria.* As an additional illustration of the occurrence of western halophytes in eastern America may be noted the occurrence about the Gulf of St. Lawrence of *Erigeron lonchophyllus, Aster angustus*, and *Aster laurentianus*, endemic representa-

[1] St. John, Harold and W. D. Courtney. The Flora of Epsom Lake. Am. Journ. Bot. **11**: 100–107. 1924.

[2] Upham, Warren. Geographic Limits of species of plants in the basin of the Red River of the North. Boston Soc. Nat. Hist. Proc. **25**: 140–172. 1890.

[3] Coville, F. V. Botany of the Death Valley Expedition. Cont. U. S. Nat. Herb. **4**: 1893.

tive of *A. frondosus*.[1] The significance of the distribution of these halophytes of the Atlantic coast in western North America will be considered under the following headings.

The interior Distribution of Halophytes by Factors other than the Champlain Sea.

Other factors than the Champlain Sea are involved in the interior distribution of the halophytes and indifferent halophytes. These may be summed up as transportation factors (canals, railroads, winds and birds), environmental factors (temperature, marl and limestone deposits, and drainage conditions).

1. Transportation by canals and railroads.—The early decades of the nineteenth century saw a great increase in transportation, initiated by the building of canals, soon followed by railroads. The Erie Canal, opened in 1825, established a waterway from the sea to the Great Lakes by way of the Mohawk Valley, and with the Champlain and Oswego Canals forms a series of canals traversing New York State, bringing into continuous waterway communication Lake Champlain, the Atlantic Ocean and the Great Lakes. It seems inevitable that canal boats in passing up the Hudson River should have carried with them plumed seeds of *Typha angustifolia* and *Scirpus fluviatilis*, seeds of mud-loving plants, as *Eleocharis diandra*, and occasionally the seeds of true halophytes. To-day, in the old Erie Canal bed between Amsterdam and Fort Hunter, one may see *Typha angustifolia* and *Phragmites communis* struggling along under what are obviously unsuitable conditions, and since these plants are not noted in the adjacent Mohawk River, one comes to the conclusion that they were dependent upon the canal for their presence. To what extent canals and railroads have been effective in the transfer, however, of halophytes into western New York, can only be conjectured. A few, for example, *Triglochin maritima* and *Eleocharis rostellata*, occur in bogs remote from transportation routes, and many were recorded by Pursh and by Torrey[2] before the advent of canals and railroads. Pursh[3] mentions

[1] See Rhodora **12**: 225–227. 1910, and **16**: 57–61. 1914.

[2] Torrey, John. Flora of New York. 1843.

[3] Pursh, Frederick. Journal of a Botanical Excursion in the Northeastern part of the State of Pennsylvania and New York, during the year 1807. Philadelphia, 1869. See page 54. For a review of early Jesuit accounts of the Onondaga salt springs and development of the salt fields, see F. J. H. Merrill: Salt and Gypsum Industries of New York. N. Y. State Mus. Bull. **11**: 1893.

in 1807 the presence of *Samolus floribundus*, *Salicornia europaea*, *Triglochin maritima*, *Ranunculus Cymbalaria* and *Hibiscus Moscheutos* in the marshes about Onondaga Lake. Yet salt manufacture was being carried on at that early period, and for over a century the springs had been visited by Jesuits and Indians coming often from remote distances, and who in their incursions in the quest of salt may unconsciously have carried about with them the seeds of maritime plants.

That these halophytes are easily and rapidly spread may be seen from observations on *Potamogeton crispus* by Hull,[1] and from Farwell's notes on the occurrence of *Salicornia europaea*, *Aster subulatus*, and *Pluchea camphorata* about the salt works in Michigan. To quote from Farwell,[2] "We can only surmise that they may have been brought west by means of railway freight traffic and when lodgement was made in this section, which provided the proper saline conditions suitable for their development, they persisted and have made flourishing colonies that are rapidly extending over the entire section which has been made saline by means of the escaping waters from the mine and the salt crushers." Similarly Fernald and Wiegand[3] record the introduction of *Spergularia marginata* on the saline borders of Onondaga Lake, and Wiegand[4] has recently described a new species, *Spergularia alata* from central New York.

2. TRANSPORTATION BY WINDS AND BIRDS.—Of transportation by winds but little can be said, except that under present climatic conditions, transportation of maritime plants into the Great Lakes from the seacoast, would tend to be slightly reduced, since moist east winds would tend to hinder the passage of plumed seeds. With the influence of salt carried by ocean winds upon the interior distribution of plants, the writer proposes to deal in a succeeding paper.

As regards seed transportation by birds, we are concerned in the comparatively small area included under the Champlain submergence, not with bird migrations, but with more or less customary inland flights. Birds in migrating over long distances do not, as a rule, carry seeds,[5] but it is conceivable that aquatic resident birds, such

[1] Hull, Edwin D. Advance of *Potamogeton crispus*. RHODORA **15**: 171–172. 1913.

[2] Farwell, O. A. New Ranges for Old Plants. RHODORA **18**: 243–244. 1916.

[3] RHODORA, **12**: 157–163. 1910.

[4] RHODORA, **22**: 15–16. 1920.

[5] For a discussion of this subject see M. L. Fernald: Botanical Expedition to Newfoundland, RHODORA **13**: 143–145, 1911, and Theodore Holm: Canadian Arctic Expedition, 1913–1918, **5**: 79B, 80B, and 112B. 1922.

as gulls, might do so, and if seeds were carried it might be expected that those of halophytes would be present. Seagulls come far inland in the regions occupied by the Champlain Sea; the writer has observed them in the Mohawk River near Schenectady, on the Lamoille River near Montpelier, Vermont, and on the St. Lawrence River, some miles above Quebec.

Bailey[1] describes the presence of diatoms belonging to marine genera in the saline lakes of Saskatchewan. Though their presence has been suggested as being due to migratory birds, it is found that the species are unlike those of the Atlantic or Pacific seaboard.

3. THE INFLUENCE OF LIMESTONE AND MARL DEPOSITS.—In a previous note mention was made of indifferent halophytes which were characteristic of calcareous areas. Such plants might be exemplified by *Potamogeton Friesii*, *P. filiformis*, *P. pectinatus*, *Myriophyllum exalbescens*, and *Sagittaria heterophylla*, which in New England and the Maritime Provinces are confined to brackish lagoons and river estuaries along the coast and to interior calcareous regions such as Berkshire County in Massachusetts, Coos County in New Hampshire, and Aroostook County in Maine. St. John[2] makes similar observations of plants on the Labrador coast growing in proximity to the seashore but otherwise confined to calcareous regions of the interior. Professor Fernald records the presence of *Juncus balticus* var. *littoralis* and *Triglochin maritima* in the upper St. John Valley of Maine, and describes as follows the vegetation of Caribou Bob in Crystal, Aroostook County,[3] "we note that the peculiar association of species which is found on Caribou Bog (and so far as we know on no other bog of New England) is repeated in many of its details on the famous Bergen Swamp in Genessee County, New York, a swamp which 'has long been considered one of the most interesting botanical points in western New York,' and in similar marshes in Wayne County, New York . . . These three bog-areas, then, are very similar in their vegetation and are characterized by a remarkable aggregation of rare or local species derived from very dissimilar floras: some of the species being characteristic of the prairies of the interior, others as typical of the Atlantic coast or even of our salt marshes; some well known northern calciphile, others ordinarily

[1] Bailey, L. W. An Annotated Catalogue of the Diatoms of Canada showing their Geographical Distribution. Contributions to Can. Biol. **2**: 31–68. 1924.

[2] Can. Dept. Mines. Memoir **126**: 36. 1922.

[3] RHODORA **12**: 118, 119. 1910.

as distinctly calcifuge species. The association of these plants, especially such species as *Triglochin maritima*, *Phragmites communis*, *Scirpus caespitosus*, *Tofieldia glutinosa*, *Habenaria leucophaea*, *Arethusa bulbosa*, *Drosera linearis*, and *Lonicera oblongifolia*, some of which are entirely unknown on other bogs of New England and New York, indicates some common feature of these bogs which it will be very enlightening to work out. A somewhat similar association of plants, with a slight variation in the exact species, occurs in some of the marly bogs on the coast of the Gaspé peninsula, where there is a remarkable mingling of marl-swamp types with the characteristic plants of sphagnum bogs and even of brackish or saline shores."[1]

It is, however, not so remarkable to find plants of the seacoast occurring in calcareous regions, for limestones have essentially been formed in marine waters and unless greatly metamorphosed should contain and liberate by solution most of the salts normally found in coastal lagoons and estuaries. Drainage in these areas is apparently significant. It is the writer's experience that where rapid drainage of water occurs, as, for example, the underground drainage in the limestone region of Middle Tennessee and Kentucky, these indifferent halophytes are practically absent. We may infer that the glacial period, in which moraine of various types was deposited, resulting in the formation of lakes and swamps, and the deviation of river channels, brought about conditions more favorable for the spread of the indifferent halophytes such as *Scirpus* and *Potamogeton* than may have occurred in the period immediately preceding glaciation. Such regions of deposition accumulate salts and provide quiet waters suitable for plant growth; moreover such areas close to sea-level would tend to be submerged by a marine invasion such as the Champlain submergence. Herein seems to be a solution of the problem. Granting that indifferent halophytes follow to some extent the area of the Champlain submergence, their presence is undoubtedly to be attributed to the fact that they are occupying deposition areas which afford the necessary salts and an environment somewhat similar to the brackish regions adjacent to the coast.

ROUTES OF MIGRATION OF HALOPHYTES INTO THE GREAT LAKES.—Since the early botanists stressed the idea that vegetation within the limits of the ice sheet had disappeared during glacial time and

[1]For observations on these swamps of New York, see Metcalf & Griscom, Rare New York State Plants, RHODORA **19**: 28-37, 48-55. 1917; and Beckwith & Macauley, Plants of Monroe County, New York, Proc. Rochester Acad. Sci **3**:1-150 1894.

that plant migration into this area ensued when the ice had sufficiently withdrawn, the question presents itself as to the routes by which these halophytes reached the Great Lakes. Like the bog plants just mentioned, these so-called maritime plants do not represent a homogeneous group, but are composed of representatives of various types, true psammophytes, such as *Ammophila breviligulata*, *Euphorbia polygonifolia*, and *Hudsonia ericoides;* psammophilous halophytes, such as *Lathyrus maritimus*, *Juncus balticus* var. *littoralis*, and *Cakile edentula;* plants boreal in distribution, such as *Triglochin maritima* (south along the coast to New Jersey), *Triglochin palustris* (south to New Hampshire), and *Ranunculus Cymbalaria* (south to Connecticut); and plants of southern distribution coming north to New England or southern Nova Scotia, as *Hibiscus Moscheutos* and *Eleocharis rostellata*. It is scarcely to be considered that all migrated simultaneously, but that boreal types, corresponding to the arctic fauna of the Champlain Sea, first made their appearance (See Antevs, l. c., p. 90–91), followed by southern types. Although no definite facts can be established, due to the paucity in America of fossil plants of this period, yet three main routes of migration present themselves, as follows:

1. By railway and canal from the Atlantic seaboard, through the Mohawk Valley, a topic which has already been discussed with reference to *Spergularia marginata*, *Potamogeton crispus*, *Aster subulatus*, *Pluchea camphorata*, and others.

2. By the St. Lawrence Valley. This is the natural route for psammophytes such as *Ammophila breviligulata*, which penetrate inland along sandy shores, and which Kearney (l. c.) has shown are not halophytes; and for true halophytes which may have been introduced by the Champlain Sea, although it is doubtful whether the Champlain Sea was greatly instrumental in the introduction of halophytes into the Great Lakes region. Many halophytes such as *Eleocharis rostellata*, *Juncus Gerardi*,[1] *Spartina alterniflora* var. *pilosa*, and *Najas marina* do not occur northward to the Gulf of St. Lawrence, and the same is true of indifferent halophytes, notably *Hibiscus Moscheutos*, *Samolus floribundus*, and *Typha angustifolia*. *Ruppia maritima*,[2] *Scirpus nanus*, *Scirpus campestris* var. *paludosus*,

[1] *Juncus Gerardi* occurs in eastern Newfoundland. The citation from Vermont (See Gray's Manual 7th ed. p. 270) was based upon plants derived from discarded packing material.

[2] See Fernald, M. L. & K. M. Wiegand. The Genus *Ruppia* in Eastern America. Rhodora **16:** 119–127. 1914. On page 126 is a description of var. *onondagensis*

Salicornia europaea and *Chenopodium rubrum* remain as true halophytes which may possibly have been introduced into the region of the Great Lakes by the Champlain Sea, but there is no evidence, except perhaps in the case of *Ruppia* (see footnote). It has been clearly shown that marine waters did not occupy the Hudson Valley during this period, and therefore natural introduction of maritime plants by this route is out of the question.

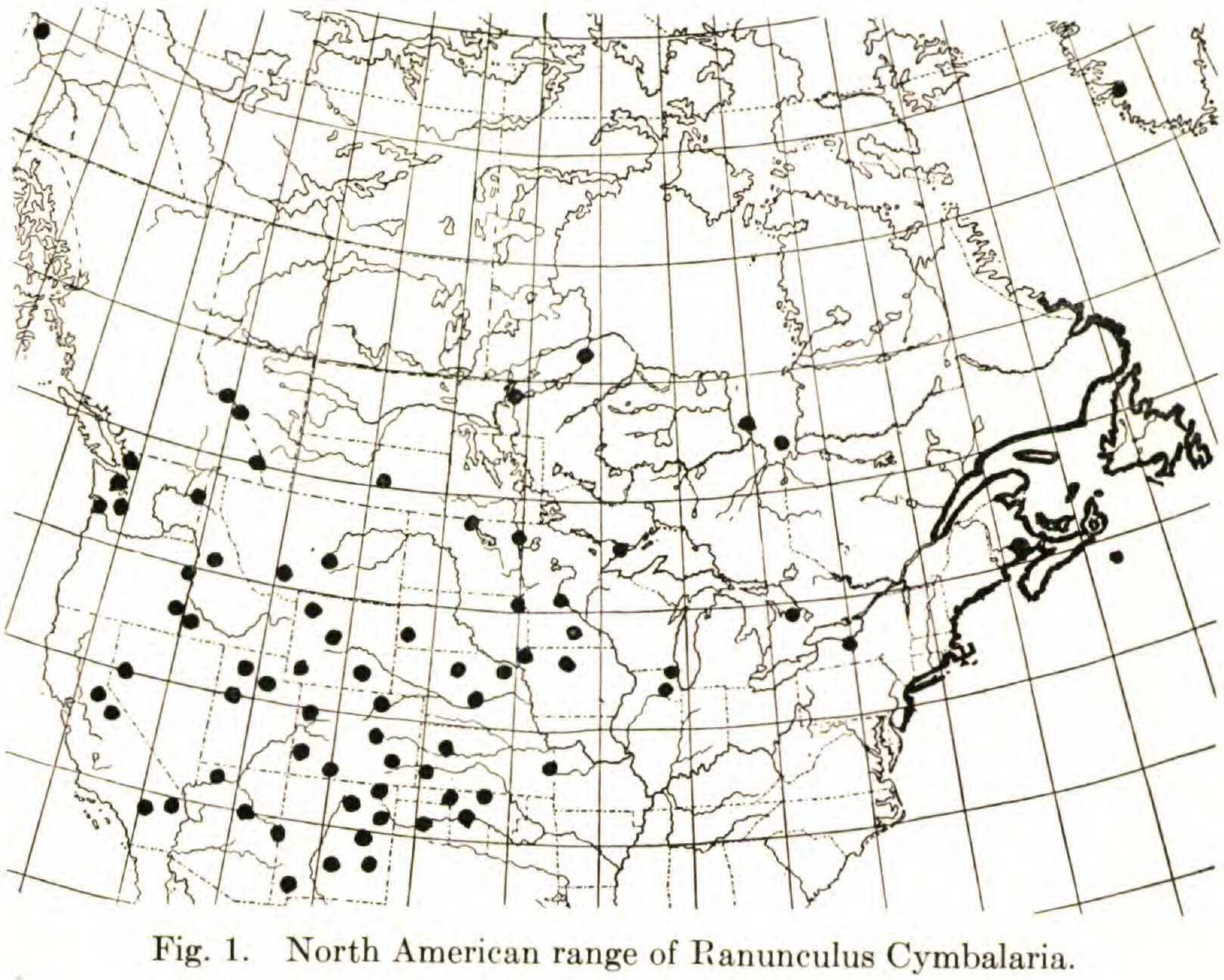

Fig. 1. North American range of Ranunculus Cymbalaria.

3. From regions adjacent to the glaciated area.

There is the possibility that many plants native to the saline regions of central New York during the last interglacial period survived in regions adjacent to the advancing or retreating ice, wherever salt was contributed by springs or moraine. What seems more probable, however, is that plants of boreal tendencies, such as *Triglochin maritima*, *Triglochin palustris*, and *Ranunculus Cymbalaria* (see fig.

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from Onondaga Lake. "From var. *subcapitata* which is apparently frequent about the Gulf of St. Lawrence, it is at once distinguished by its long peduncle; but its podogynes and fruits so closely resemble those of the latter plant as to suggest that var. *onondagensis* is a derivative of the maritime var. *subcapitata* which has become slightly altered in its isolated inland habitat.

1), which have by far their greatest distribution in western America, migrated eastward. The similarity of the present halophilous vegetation of the West with that of central New York and the Atlantic coast, has already been stressed by Upham (l. c.) and by St. John (l. c.). At the time of recession of the ice sheet, a great area with homogeneous temperature and humidity must have extended along the front of the retreating ice with a terrain adapted to the growth of aquatic or semi-aquatic plants, and in alkaline regions to halophilous plants, making possible an extensive west to east as well as south to north migration. Upon retreat of the ice cap, relics of the northern saline types would thus be left in mountainous regions, about saline springs, or in cold calcareous bogs. A similar expansion of more southern halophytes and indifferent halophytes would naturally follow. From this point of view it seems as logical to consider *Ranunculus Cymbalaria* at Onondaga Lake as the most eastern station of an extensive area in the west as to consider it an interior migrant from the Atlantic seaboard.

The origin of the halophytic flora of the Great Lakes, therefore, appears to be complex, involving not only the question of post-Pleistocene submergence, but also the question of postglacial migrations from the West, and of apparently most importance, transportation by human agencies.

Summary.

From review of literature and from investigation the writer finds that maritime plants (halophytes) do not persist inland in eastern North America by reason of the post-Pleistocene marine submergence, unless salt springs or equivalent conditions are present, as in certain regions of New York and New Brunswick. No vascular plants of characteristically brackish habitat (indifferent halophytes) appear to be confined throughout their distribution in New England and the Maritime Provinces to the region occupied by the marine submergence, but their distribution inland is usually confined to low lying areas adjacent to the sea, or to inland areas with impeded drainage where the underlying rocks are calcareous. The botanical evidence of oceanic submergence offered by early writers is of little value It does not seem that maritime plants (halophytes) have by natural means entered the Champlain or Ontario basins by way of the Hudson valley, but that they have come partly by way of the Gulf of St.

Lawrence and partly from the west and southwest after sufficient removal of the ice to the northward. Human agencies have been perhaps the most effective means of distributing these plants.

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THE VALIDITY OF THE GRASS GENUS DIGITARIA.

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DIGITARIA, as generally accepted (for a genus or a section of *Panicum*) for the last hundred years, has included *Panicum sanguinale* L. and its allies. *Digitaria* was rejected by Nash[1] because it was thought to be a homonym of *Digitaria* "Heister (Adans. Fam. Pl. **2**: 38. 1763)," and *Syntherisma* was accepted in its place. A re-examination of the evidence shows that *Digitaria* should be accepted as valid, *Panicum sanguinale* L. being selected as the standard species.

The first use of the name *Digitaria* was by Fabricius[2] where it is credited to Heister, "Digitaria Heist.; Dactylis Rai. Gramen dactylon majus panicula longa, spicis pluribus nudis crassis. Sloane." The Sloane reference given by Fabricius is cited by Linnaeus[3] under *Panicum dissectum*. Under the American Code *Panicum dissectum* has been assumed to be the type of *Digitaria* Heist. because the two names are "associable by citation," which fact also established effective publication under that code. In an investigation of the Linnaean types of American grasses[4] it was found that the Sloane reference was cited by Linnaeus under *Paspalum virgatum* in 1759, as well as under *Panicum dissectum* in 1753. The specimen in the Sloane Herbarium is *Paspalum virgatum*.

I think this reference of Sloane's plant to *Digitaria* by Fabricius should be considered an error, a misidentification. The identification was doubtless made from the plate in Sloane's work. European botanists at that time had a very vague idea of the tropical American flora and too much weight should not be given to the citation of exotic references. It appears that Fabricius himself recognized his error for in the second edition of his work[5] he omits the Sloane refer-

[1] Britt. & Brown, Illustr. Fl. **1**: 110. 1896.
[2] Fabr. Enum. Pl. Hort. Helmst. 207. 1759.
[3] Sp. Pl. 57. 1753.
[4] Hitchcock, Contr. U. S. Nat. Herb. **12**: 133. 1908.
[5] Fabr. Enum. Pl. Hort. Helmst. ed. 2. 374. 1763.